Fachartikel

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WIGGINS TEAPE

"Fast laser pulses can etch a pattern on a moving part on a production line"

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certain that prices are set from company headquarters and cannot be altered by store managers. He adds that the company is working with the local sealer of weights and measures to verify operation of the electronic scales and other hardware.

A remaining problem in scanner operation is small packages with abbreviated UPC symbols. On such small items as chewing-gum packages, Dawson says, mandatory zero suppression and abbreviation make reading sensitive to orientation when the UPC symbol is passed over the scanner; specifications for the fullscale symbol require that it be readable regardless of its orientation. Reflection from aluminum or bright-gold backgrounds also has caused problems, but Dawson says these are being solved. Quality of the printing of symbols has not been a problem, but some food packagers have supplied incorrect lists of product-code numbers, or used the same number for different products.

As of April 22, he said that 44% of items in the Troy store were scannable; according to the Super Market Institute the nationwide average was 50% in January. Dawson says the percentage of scannable items is increasing, and may show large increases when large manufacturers exhaust their stock of uncoded items. But he doubts that the Super Market Institute's estimate of 90% source marking by the end of the year will be true for the Ohio region.

The Troy market began phasing out item pricing May 12. One aisle at a time it stopped marking prices on goods; first to lose their price marks were items with the highest volume. A week after the test began, IBM's large share of the scanning installations reflects both the industry giant's domination of the computer field and its emphasis on scanning; not until the Super Market Institute meeting did IBM emphasize its alternative scannerless system. NCR, in contrast, has been emphasizing sales of scannerless systems which are upgradable to scanning when sufficient numbers of items are source-marked with the Universal Product Code. In addition to IBM's 11 laser installations and NCR's two at the end of April, Univac had installed two laser scanning systems and Data General one system that uses handheld laserless wands.

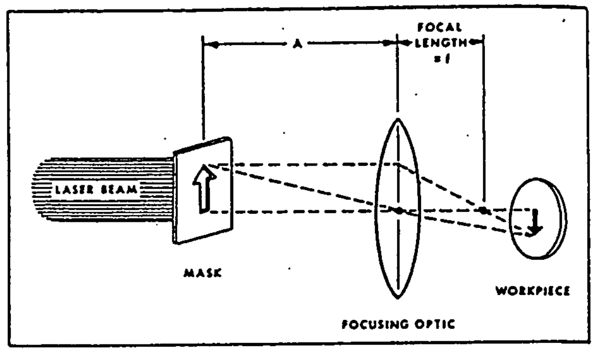
Test sites are spread across the country, but the distribution shows one irony. The most installations — three — are in Massachusetts, where a legislative committee has ruled that laws require item pricing [LF May p54].

Fast laser pulses can etch a pattern in a moving part on a production line

Unlike more stationary operations such as welding and drilling, laser machining of a pattern requires considerable time-consuming motion of the beam or workpiece. By placing the pattern on a mask and imaging the mask on the workpiece with a fast-pulsing, high-energy laser, however, a pattern can be etched on a surface moving rapidly along a production line.

Such a system, developed around a transversely excited carbon-dioxide laser at Lumonics Research Ltd.,

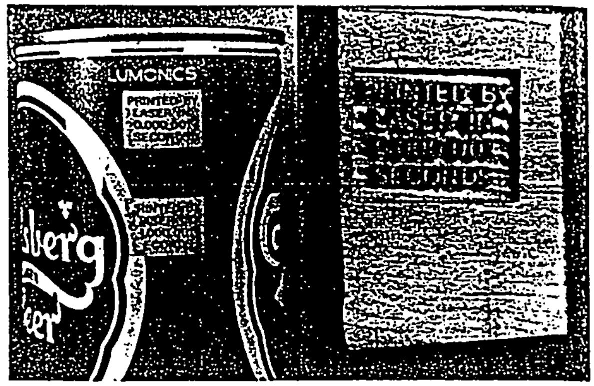
For proper image formation, the laser pulse must uniformly illuminate the mask, which can be a transmissive stencil or a reflective pattern; a transmissive mask is simplest to image. A lens or mirror collects the laser energy that passes through or is reflected by the



IMAGING A MASK onto a workpiece is shown with transmissive optics. Image size is reduced by a factor of (A/f)-1

mask, then focuses it on the workpiece. Image size is chosen to provide energy density sufficient to remove the desired amount of material.

The carbon-dioxide laser used by Lumonics emits pulses of 50 nanoseconds to 50 microseconds; typical effect of these 10.6-micrometer pulses is vaporization of a surface layer. Depth of penetration depends upon target absorption as well as pulselength and energy density. Such nonmetals as plastic, wood, paper, paint and glasses are highly absorbent and therefore readily



WOOD at right is not burned because of short lengths of laser pulses; paint is removed from beer can at left with a single pulse

vaporized, Dr. Buchanan says, but metals' high reflectivities at 10.6 μm makes them difficult to work except when removing a surface coating.

Single pulses etch the surface; repeated pulses remove further levels of material and can produce decorative effects. With enough pulses, the pattern can be etched completely through the material; in certain cases this can be done with only a single pulse. The energy is "well confined to the desired areas," Buchanan says, "and very little force is applied to the work."

Advantages and disadvantages

Buchanan cites several advantages of Lumonics' imaging method over conventional laser techniques:

- No need for programed movement of laserbeam or workpiece.
- Resolution limited by laser wavelength and quality of the optics rather than by beam divergence. "In fact, a highly multimode output is desirable because of its uniform illumination."
- A one-microsecond laser pulse can etch symbols on many materials, permitting application to rapidly moving workpieces, including those on production lines, without blurring. Loss of resolution is only 50 μm for a target moving at 50 meters per second, he explains.
- Pulse rates of high-average-power "tea" lasers can reach several hundred per second, permitting high production rates.
- Patterns can be as large as several square centimeters, with resolution to 0.001 inch.
- Automatic mask interchange permits marking of successive items with different patterns, important for such applications as serial numbering.
- The laser can be fired on a lowlevel trigger pulse to select one mask from a moving array or to image on a moving workpiece; this is possible because of the laser's 50-nanosecond jitter and 1.5-μs delay.

One disadvantage is the loss of energy screened out by the mask; Buchanan says this loss can be reduced by placing the mask inside the laser cavity. The technique also requires energy densities of 10 joules per square centimeter at the workpiece, making high-energy pulses necessary for large-area images.

Woodworking and data stamping

Lumonics is working with manufacturers to develop applications for the imaging technique. Several applications are being explored:

• Dates can be marked on food and beverage containers by removing paint from metal or ink from a label; laser imaging permits rates of several hundred per second without stopping moving packages.

• Patterns in wood that look like intricate carvings can be produced by deep penetration of patterns into the wood surface. Because of the short laser pulses, the wood does not burn.

• Multilayer plastics can be engraved by removing the top layer with a laser pulse, exposing the colored material below.

• Rubber stamps can be manufactured with the required reversed image, with multiple pulses forming a deep pattern.

• Thin-metal layers can be removed from glass or ceramic substrates for such applications as electronic-circuit manufacture.

Telephone and video communications seen as applications for optical fibers

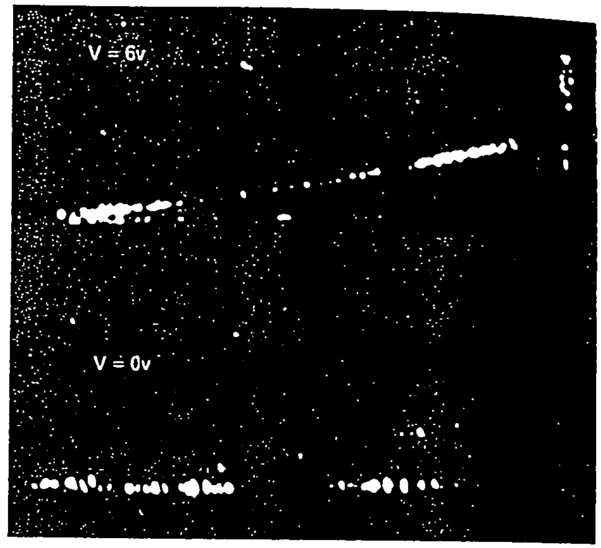
Fabricating optical fibers for telephone cabling would require only one-thousandth the energy needed to make conventional copper-wire cabling, John F. Fulenwider of GTE Laboratories Inc. told the international convention of the Institute of Electrical and Electronics Engineers April 8 in New York. Farther in the future, he said, optical fibers and integrated optics could provide a video-communication network to link a "wired city." Such applications would require tremendous quantities of fibers, light sources and other optical components.

Most promising applications for optical fibers are remote signaling and point-to-point communications on switched or dedicated lines, according to Dr. Fulenwider. He cited such examples as cable television, control and indicator wiring in hospitals and defense communications; among the desirable properties of fibers he cited were low installation cost, electrical isolation and savings in bulk and weight.

Optical-fiber transmission can be applied in trunk-line transmission between telephone offices and in loop lines between telephone office and user; switching applications are possible "eventually," he added. Telephone equipment is turning to digital techniques, which "adapt directly to optical-fiber transmission." Such transmission would be desirable for interoffice trunks because of "the bandwidth available with fibers, their small size and potential low cost. . . With interoffice traffic showing longterm growth of about 15% in circuit miles per year and metallic telephone-cable prices rising . . . there is a need for new circuits with lower-cost technology. Optical-fiber cables can easily meet the bandwidths required for [certain] carrier routes. Fewer repeaters are required per circuit than with screened metallic cable."

Growth in cabling to telephone users is about nine million pair miles per year, he continued. With the small size of fibers "taking up significantly less duct space than comparable-capacity metallic cable, and low weight achieving reduced manhours per installation, reduced trucking weight and smaller pulling apparatus, circuit-for-circuit optical-fiber transmission techniques should be less costly than their metallic equivalents."

By 1990, he estimated, optical fibers would account for 20% of interoffice trunks and 15% of loop cabling, for a total of 36 million miles of singlestrand fibers. Production of this quantity of glass would require the equivalent of 450 tons of coal; production of an equivalent amount of 22-gage copper wire from ore would require the equivalent of 400,000 tons of coal.



Optical switch

Based on coupling of two waveguides by electric fields, this optical switch was constructed at Thomson-CSF by diffusing titanium into a lithium-niobate substrate. Unlike other designs for an electrically switched directional coupler, the "Cobra" coupler has electrodes deposited on the waveguides. Light from an argon laser was coupled into one of the waveguides; the photographs show light observed at the exit end with electrode voltages of 0 and 6 volts and a TM guided wave. The Thomson-CSF group, headed by M. Papuchon and Daniel B. Ostrowsky, believes that more than 50% of the light was switched between waveguides; current research goals are to improve performance and develop applications.

Spurred by interest in interactive communications, the wired city would provide a video-communications network linking homes, businesses and other facilities. Requiring a bandwidth of about 300 megahertz, the network would give access to information centers, entertainment and other services and provide face-to-face communication and interfaces that its advocates say would allow many people to work at home. "Present concepts of the wired city require a coaxial-cable network," according to Fulenwider, "but optical-fiber cable and transmission techniques could be a viable alternative."

Such a wired city would mean "staggering changes in the way we live." But it would be expensive — Fulenwider "conservatively" estimated complete conversion to optical-fiber transmission "when the technology has matured" would cost at least $1,500 per customer. "However, putting the concept into practice in smaller steps, each budgeted and defensible as a cost-cutting technique . . . would likely be followed [by] implementing wired cities with optical-fiber communications."

Remote sensing and cable tv

Remote sensing applications "become particularly interesting when the environment contains explosive gases or dust . . . the chief advantage of optical fibers is their electrical isolation and small crossection." In hospitals and certain industrial buildings, building